

Article 34 Amendment

Dated: July 6, 2004

AMENDMENT (Translation)

(Amendment under Art. 11)

To: Commissioner, Patent Office

5

1. Identification of the International Application

PCT/JP2004/000742

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4. Date July 6, 2004

5. Object of Amendment

25 Specification, Claim and Drawing

6. Contents of Amendment

(1) "To achieve the objects, according to an aspect of the present invention, in an electrode for discharge surface treatment ..." in page 4, lines 16 to page 7 line 5 of the Japanese text is amended as follows:

To achieve the objects, according to an aspect of the present invention, in an electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, the powder has an average value of particle diameters not more than 3 micrometers, and the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers.

According to another aspect of the present invention, in an electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal, a metallic compound, or ceramics as an electrode,

electric discharge between the electrode and a work piece
in a machining fluid or in an air and forming, using discharge
energy of the electric discharge, a film consisting of an
electrode material or a substance generated by reaction
5 of the electrode material due to the discharge energy on
a surface of the work piece, the powder has a scaly shape.

According to still another aspect of the present
invention, in an electrode for discharge surface treatment
that is used for discharge surface treatment for causing,
10 with a green compact obtained by compression-molding powder
of metal or a metallic compound as an electrode, electric
discharge between the electrode and a work piece in a
machining fluid or in an air and forming, using discharge
energy of the electric discharge, a film consisting of an
15 electrode material or a substance generated by reaction
of the electrode material due to the discharge energy on
a surface of the work piece, the electrode material of the
electrode is capable of forming a thick film with thickness
not less than 100 micrometers, the powder is obtained by
20 mixing a small-diameter powder having a distribution of
small particle diameters and a large-diameter powder having
an average particle diameter twice or more as large as the
small-diameter powder, and the large-diameter powder is
a mixture in 5 to 60 volume percent.

25 According to still another aspect of the present

invention, in an electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal, a metallic compound, or ceramics as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers, and the powder has an average value of particle diameters not more than 1 micrometer.

Moreover, to achieve the objects, according to still another aspect of the present invention, a manufacturing method for an electrode for discharge surface treatment, includes a first step of grinding powder of metal, a metallic compound, or ceramics into a spheric powder having a predetermined particle diameter and scaly shape with a grinder; and a second step of compress-molding the powder ground into a predetermined shape to have predetermined hardness.

Moreover, to achieve the objects, according to still another aspect of the present invention, in a discharge surface treatment method of causing, with a green compact

obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, the film is formed using an electrode obtained by compression-molding powder with an average value of particle diameters not more than 3 micrometers, using the electrode made of the electrode material that is capable of forming a thick film with thickness not less than 100 micrometers.

According to still another aspect of the present invention, in a discharge surface treatment method of causing, with a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, in the film is formed using an electrode obtained by mixing a small-diameter powder having a distribution of small particle diameters and a

large-diameter powder having an average particle diameter twice or more as large as the small-diameter powder and compression-molding the powders, the large-diameter powder being in 5 to 60 volume percent, and using the
5 electrode made of the electrode material that is capable of forming a thick film with thickness not less than 100 micrometers.

According to still another aspect of the present invention, in a discharge surface treatment method of
10 causing electric discharge between an electrode made of electrode material that is capable of forming a thick film with thickness not less than 100 micrometers and consisting of a green compact obtained by compression-molding powder with an average value of particle diameters not more than
15 1 micrometer and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece.

20 Moreover, to achieve the objects, according to still another aspect of the present invention, in a discharge surface treatment apparatus that has an electrode consisting of a green compact obtained by compression-molding powder containing metal or a metallic
25 compound and a work piece on which a film is formed, the

electrode and the work piece being arranged in a machining fluid or in an air, generates a pulse-like electric discharge between the electrode and the work piece using a power supply apparatus electrically connected to the electrode and the work piece, and forms, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, the powder has an average value of particle diameters not more than 3 micrometers, and the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers.

According to still another aspect of the present invention, a discharge surface treatment apparatus includes an electrode consisting of a green compact obtained by compression-molding powder of metal or a metal compound; a work piece on which a film is formed; and a power supply apparatus electrically connected to the electrode and the work piece, the discharge surface treatment apparatus generating pulse-like electric discharge between the electrode and the work piece with the power supply apparatus and forming, using discharge energy of the discharge, a film consisting of an electrode material or a substance

generated by reaction of the electrode material due to the discharge energy on a surface of the work piece. The electrode is manufactured from an electrode material that is obtained by mixing a small-diameter powder having a distribution of small particles and a large-diameter powder having an average particle diameter twice or more as large as the small-diameter powder, the large-diameter powder being in 5 to 60 volume percent, and the electrode material being capable of forming a thick film with thickness not less than 100 micrometers.

According to still another aspect of the present invention, in a discharge surface treatment apparatus includes an electrode is made of an electrode material that is capable of forming a thick film with thickness not less than 100 micrometers consisting of a green compact obtained by compression-molding powder with an average value of particle diameters not more than 1 micrometer; a work piece on which a film is formed; and a power supply apparatus electrically connected to the electrode and the work piece, the discharge surface treatment apparatus generating pulse-like electric discharge between the electrode and the work piece with the power supply apparatus and forming, using discharge energy of the discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge

energy on a surface of the work piece.

(2) Claims 1, 2, 5, 7 to 9, 16, 17, 19, 26 to 29, 38, 39,
43 to 46, 55, are amended as per the attached sheets and
5 claims 6, 14, and 34 are deleted.

7. List of accompanying documents

(1) Specification pages 4 to 7/1.

(2) The scope of claims for patent, pages 43 to 54.

Moreover, since powder manufactured by the atomizing method is manufactured by evaporating a material and condensing the material, obtained powder has a spherical shape because of an influence of a surface tension. There is also a
5 problem in that, when an electrode is formed of such spherical powder, since powder particles are in point contact with one another, bonding among the particles is weakened to make the powder fragile.

The present invention has been devised in view of
10 the problems and it is an object of the present invention to obtain an electrode for discharge surface treatment that has uniform hardness, has uniform thickness at the time of the discharge surface treatment, and is capable of forming a thick film with thickness not less than about
15 100 micrometers.

It is another object of the present invention to obtain an electrode for discharge surface treatment that has uniform hardness and is capable of forming a uniform and sufficiently dense thick film at the time of the discharge
20 surface treatment. It is still another object of the present invention to obtain an electrode for discharge surface treatment that is capable of forming a thick film having abrasion resistance and lubricity under a high-temperature environment.

25 It is still another object of the present invention

to obtain a discharge surface treatment apparatus that uses the electrode for discharge surface treatment and a method for the discharge surface treatment apparatus.

5 **DISCLOSURE OF INVENTION**

To achieve the objects, according to an aspect of the present invention, in an electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by
10 compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or
15 a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, the powder has an average value of particle diameters not more than 3 micrometers, and the electrode material of the electrode is capable of forming a thick film with thickness
20 not less than 100 micrometers.

According to another aspect of the present invention, in an electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of
25 metal, a metallic compound, or ceramics as an electrode,

electric discharge between the electrode and a work piece
in a machining fluid or in an air and forming, using discharge
energy of the electric discharge, a film consisting of an
electrode material or a substance generated by reaction
5 of the electrode material due to the discharge energy on
a surface of the work piece, the powder has a scaly shape.

According to still another aspect of the present
invention, in an electrode for discharge surface treatment
that is used for discharge surface treatment for causing,
10 with a green compact obtained by compression-molding powder
of metal or a metallic compound as an electrode, electric
discharge between the electrode and a work piece in a
machining fluid or in an air and forming, using discharge
energy of the electric discharge, a film consisting of an
15 electrode material or a substance generated by reaction
of the electrode material due to the discharge energy on
a surface of the work piece, the electrode material of the
electrode is capable of forming a thick film with thickness
not less than 100 micrometers, the powder is obtained by
20 mixing a small-diameter powder having a distribution of
small particle diameters and a large-diameter powder having
an average particle diameter twice or more as large as the
small-diameter powder, and the large-diameter powder is
a mixture in 5 to 60 volume percent.

25 According to still another aspect of the present

invention, in an electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal, a metallic compound, or ceramics as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers, and the powder has an average value of particle diameters not more than 1 micrometer.

Moreover, to achieve the objects, according to still another aspect of the present invention, a manufacturing method for an electrode for discharge surface treatment, includes a first step of grinding powder of metal, a metallic compound, or ceramics into a spheric powder having a predetermined particle diameter and scaly shape with a grinder; and a second step of compress-molding the powder ground into a predetermined shape to have predetermined hardness.

Moreover, to achieve the objects, according to still another aspect of the present invention, in a discharge surface treatment method of causing, with a green compact

obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, the film is formed using an electrode obtained by compression-molding powder with an average value of particle diameters not more than 3 micrometers, using the electrode made of the electrode material that is capable of forming a thick film with thickness not less than 100 micrometers.

According to still another aspect of the present invention, in a discharge surface treatment method of causing, with a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, in the film is formed using an electrode obtained by mixing a small-diameter powder having a distribution of small particle diameters and a

large-diameter powder having an average particle diameter twice or more as large as the small-diameter powder and compression-molding the powders, the large-diameter powder being in 5 to 60 volume percent, and using the
5 electrode made of the electrode material that is capable of forming a thick film with thickness not less than 100 micrometers.

According to still another aspect of the present invention, in a discharge surface treatment method of
10 causing electric discharge between an electrode made of electrode material that is capable of forming a thick film with thickness not less than 100 micrometers and consisting of a green compact obtained by compression-molding powder with an average value of particle diameters not more than
15 1 micrometer and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece.

20 Moreover, to achieve the objects, according to still another aspect of the present invention, in a discharge surface treatment apparatus that has an electrode consisting of a green compact obtained by compression-molding powder containing metal or a metallic
25 compound and a work piece on which a film is formed, the

electrode and the work piece being arranged in a machining fluid or in an air, generates a pulse-like electric discharge between the electrode and the work piece using a power supply apparatus electrically connected to the electrode and the work piece, and forms, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, the powder has an average value of particle diameters not more than 3 micrometers, and the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers.

According to still another aspect of the present invention, a discharge surface treatment apparatus includes an electrode consisting of a green compact obtained by compression-molding powder of metal or a metal compound; a work piece on which a film is formed; and a power supply apparatus electrically connected to the electrode and the work piece, the discharge surface treatment apparatus generating pulse-like electric discharge between the electrode and the work piece with the power supply apparatus and forming, using discharge energy of the discharge, a film consisting of an electrode material or a substance

generated by reaction of the electrode material due to the discharge energy on a surface of the work piece. The electrode is manufactured from an electrode material that is obtained by mixing a small-diameter powder having a distribution of small particles and a large-diameter powder having an average particle diameter twice or more as large as the small-diameter powder, the large-diameter powder being in 5 to 60 volume percent, and the electrode material being capable of forming a thick film with thickness not less than 100 micrometers.

According to still another aspect of the present invention, in a discharge surface treatment apparatus includes an electrode is made of an electrode material that is capable of forming a thick film with thickness not less than 100 micrometers consisting of a green compact obtained by compression-molding powder with an average value of particle diameters not more than 1 micrometer; a work piece on which a film is formed; and a power supply apparatus electrically connected to the electrode and the work piece, the discharge surface treatment apparatus generating pulse-like electric discharge between the electrode and the work piece with the power supply apparatus and forming, using discharge energy of the discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge

energy on a surface of the work piece.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a schematic of a structure of a turbine
5 blade of a gas turbine engine for an aircraft;

Fig. 2 is a schematic of discharge surface treatment
in a discharge surface treatment apparatus;

Fig. 3A is a chart of a voltage waveform of a voltage
applied between an electrode for discharge surface
10 treatment at the time of electric discharge and a work;

Fig. 3B is a chart of a current waveform of a current
flowing to the discharge surface treatment apparatus at
the time of electric discharge;

Fig. 4 is a flowchart of an example of a manufacturing
15 process for an electrode for discharge surface treatment;

Fig. 5 is a schematic sectional view of a state of
a molding device at the time when powder is molded;

Fig. 6 is a schematic of a hardness fluctuation test;

Fig. 7 is a graph of a granularity distribution of
20 stellite powder after grinding 50 hours;

Fig. 8 is an SEM (Scanning Electron Microscope)
photograph of a state of the inside of an electrode
manufactured from scaly stellite powder with an average
particle diameter of 1.8 micrometers;

25 Fig. 9 is an SEM photograph of a state of the inside

of an electrode manufactured as a comparative example from spherical stellite powder with an average particle diameter of 6 micrometers;

Fig. 10 is a photograph of a deposition state of powder
5 processed under this condition;

Fig. 11 is a schematic of a grinding principle of a bead mill apparatus;

Fig. 12 is a graph of a granularity distribution of stellite powder after grinding six hours;

10 Fig. 13 is a schematic of a constitution of an electrode material in an eighth embodiment of the present invention;

Fig. 14A is an SEM photograph of a state of a film at the time when the discharge surface treatment is
15 performed with small discharge energy using an electrode containing large-diameter powder at a ratio of 10%;

Fig. 14B is an SEM photograph of a state of a film at the time when the discharge surface treatment is performed with small discharge energy using an electrode
20 containing large-diameter powder at a ratio of 50%;

Fig. 14C is an SEM photograph of a state of a film at the time when the discharge surface treatment is performed with large discharge energy using an electrode containing large-diameter powder at a ratio of 50%;

CLAIMS

1. (Currently Amended) An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by
5 compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or
10 a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the powder has an average value of particle diameters not more than 3 micrometers, and the electrode material
15 of the electrode is capable of forming a thick film with thickness not less than 100 micrometers.

2. (Currently Amended) An electrode for discharge surface treatment that is used for discharge surface treatment for
20 causing, with a green compact obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric
25 discharge, a film consisting of an electrode material or

a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

powder having a particle diameter not more than 3 micrometers is mixed in a proportion not less than 10% in the powder, and the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers.

10 3. The electrode for discharge surface treatment according to claim 2, wherein the powder has a particle diameter varied in powder of an identical component.

4. The electrode for discharge surface treatment according to any one of claims 1 to 3, wherein the powder contains any one of stellite, Ti-coated CBN, TiC+Ti, $\text{Cr}_2\text{C}_3+\text{Cr}$, $\text{Cr}_2\text{C}_3+\text{stellite}$, $\text{Al}_2\text{O}_3+\text{Ni}$, ZrO_2+Ni , and stellite+Co.

20 5. (Currently Amended) An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal, a metallic compound, or ceramics as an electrode, electric discharge between
25 the electrode and a work piece in a machining fluid or in

an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the powder has a scaly shape.

6. (Deleted)

7. (Currently Amended) The electrode for discharge surface treatment according to claim 5, wherein an average particle diameter of the powder is not more than 3 micrometers.

8. (Currently Amended) An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a workpiece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein the electrode material of the electrode is capable

of forming a thick film with thickness not less than 100 micrometers, the powder is obtained by mixing a small-diameter powder having a distribution of small particle diameters and a large-diameter powder having an average particle diameter twice or more as large as the small-diameter powder, and the large-diameter powder is a mixture in 5 to 60 volume percent.

9. (Currently Amended) An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a workpiece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers, the powder is obtained by mixing a small-diameter powder having a distribution of small particle diameters not more than 3 micrometers and a large-diameter powder having an average particle diameter not less than 5 micrometers, and the large-diameter powder

is in 5 to 20 volume percent.

10. The electrode for discharge surface treatment according to claim 8 or 9, wherein the small-diameter powder is metal powder refined by grinding.

11. The electrode for discharge surface treatment according to any one of claims 8 to 10, wherein the large-diameter powder has a substantially spherical shape.

10

12. The electrode for discharge surface treatment according to any one of claims 8 to 11, wherein the powders to be mixed have an identical component.

13. The electrode for discharge surface treatment according to any one of claims 8 to 12, wherein the powder is any one of Co alloy, Ni alloy, and Fe alloy.

14. (Deleted)

20

15. The electrode for discharge surface treatment according to any one of claims 8 to 13, wherein the large-diameter powder is in 5 to 20 volume percent.

16. (Currently Amended) An electrode for discharge

surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal, a metallic compound, or ceramics as an electrode, electric discharge between
5 the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece,
10 wherein

the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers, and the powder has an average value of particle diameters not more than 1 micrometer.

15

17. (Currently Amended) An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal, a metallic compound,
20 or ceramics as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material
25 due to the discharge energy on a surface of the work piece,

wherein

the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers, and the powder contains a predetermined quantity or more of powder with an average value of particle diameters not more than 1 micrometer as the electrode material.

18. The electrode for discharge surface treatment according to claim 16 or 17, wherein the powder contains any one of Co powder, Co alloy powder, Mo powder, Cr powder, W powder, Zr powder, Ta powder, Ti powder, V powder, and Nb powder.

15 19. (Currently Amended) A manufacturing method for an electrode for discharge surface treatment, comprising:

a first step of grinding powder of metal, a metallic compound, or ceramics into aspheric powder having a predetermined particle diameter and scaly shape with a grinder; and

a second step of compress-molding the powder ground into a predetermined shape to have predetermined hardness.

20. The manufacturing method for an electrode for discharge surface treatment according to claim 19, wherein

the grinder is a mill apparatus.

21. The manufacturing method for an electrode for discharge surface treatment according to claim 20, wherein
5 the mill apparatus is any one of a ball mill apparatus, a bead mill apparatus, a vibrating mill apparatus, and a jet mill apparatus.

22. The manufacturing method for an electrode for
10 discharge surface treatment according to claim 20 or 21, wherein the mill apparatus includes a container and balls made of a same material as material of the powder to be ground.

15 23. The manufacturing method for an electrode for discharge surface treatment according to claim 20 or 21, wherein the mill apparatus includes a container and balls with surfaces thereof subjected to build up welding, plating, or thermal spraying using a same material as a
20 material of the powder to be ground.

24. The manufacturing method for an electrode for discharge surface treatment according to claim 20, wherein a material of the mill apparatus is ZrO_2 .

25. The manufacturing method for an electrode for discharge surface treatment according to any one of claims 19 to 24, wherein, in the first step, the predetermined particle diameter is not more than 3 micrometers.

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26. (Currently Amended) A discharge surface treatment method of causing, with a green compact obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge
10 between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface
15 of the work piece, wherein

the film is formed using an electrode obtained by compression-molding powder with an average value of particle diameters not more than 3 micrometers, using the electrode made of the electrode material that is capable
20 of forming a thick film with thickness not less than 100 micrometers.

27. (Currently Amended) A discharge surface treatment method of causing, with a green compact obtained
25 by compression-molding powder containing metal or a

metallic compound as an electrode, electric discharge
between the electrode and a work piece in a machining fluid
or in an air and forming, using discharge energy of the
electric discharge, a film consisting of an electrode
5 material or a substance generated by reaction of the
electrode material due to the discharge energy on a surface
of the work piece, wherein

the film is formed using an electrode obtained by
compression-molding powder mixed with powder having a
10 particle diameter not more than 3 micrometers mixed in a
proportion not less than 10% in the powder, and using the
electrode made of the electrode material that is capable
of forming a thick film with thickness not less than 100
micrometers.

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28. (Currently Amended) A discharge surface
treatment method of causing, with a green compact obtained
by compression-molding powder of metal or a metallic
compound as an electrode, electric discharge between the
20 electrode and a work piece and forming, using discharge
energy of the electric discharge, a film consisting of an
electrode material or a substance generated by reaction
of the electrode material due to the discharge energy on
a surface of the work piece, wherein

25

the film is formed using an electrode obtained by

mixing a small-diameter powder having a distribution of small particle diameters and a large-diameter powder having an average particle diameter twice or more as large as the small-diameter powder and compression-molding the powders, 5 the large-diameter powder being in 5 to 60 volume percent, and using the electrode made of the electrode material that is capable of forming a thick film with thickness not less than 100 micrometers.

10 29. (Currently Amended) A discharge surface treatment method of causing, with a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece and forming, using discharge 15 energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the film is formed using an electrode obtained by 20 mixing a small-diameter powder having a distribution of small particle diameters not more than 3 micrometers and a large-diameter powder having an average particle diameter not less than 5 micrometers and compression-molding the powders, the large-diameter powder being in 5 to 60 volume 25 percent, and using the electrode made of the electrode

material that is capable of forming a thick film with thickness not less than 100 micrometers.

30. The discharge surface treatment method according to
5 claims 28 or 29, wherein the small-diameter powder is powder refined by grinding.

31. The discharge surface treatment method according to
any one of claims 28 to 30, wherein the large-diameter powder
10 has a substantially spherical shape.

32. The discharge surface treatment method according to
any one of claims 28 to 31, wherein the small-diameter
particle and the large-diameter particle have an identical
15 component.

33. The discharge surface treatment method according to
any one of claims 28 to 32, wherein the powder is any one
of Co alloy, Ni alloy, and Fe alloy.

20

34. (Deleted)

35. The discharge surface treatment method according to
any one of claims 28 to 33, wherein the large-diameter powder
25 is in 5 to 20 volume percent.

36. The discharge surface treatment method according to any one of claims 28 to 35, wherein

the electrode and the work piece are arranged in a machining fluid or a predetermined gas atmosphere, and electric discharge is performed in the machining fluid or the predetermined gas atmosphere.

37. The discharge surface treatment method according to any one of claims 28 to 36, wherein a pulse current with a discharge pulse width not more than 70 microseconds and a peak current value not more than 30 amperes is supplied between the electrode and the work piece.

38. (Currently Amended) A discharge surface treatment method of causing electric discharge between an electrode made of electrode material that is capable of forming a thick film with thickness not less than 100 micrometers and consisting of a green compact obtained by compression-molding powder with an average value of particle diameters not more than 1 micrometer and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece.

39. (Currently Amended) The discharge surface treatment method of causing electric discharge between an electrode made of electrode material that is capable of forming a thick film with thickness not less than 100 micrometers and consisting of a green compact obtained by compression-molding powder including a predetermined quantity or more of powder with an average value of particle diameters not more than 1 micrometer and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece.

40. The discharge surface treatment method according to any one of claims 38 to 39, wherein

the electrode and the work piece are arranged in a machining fluid or a predetermined gas atmosphere, and electric discharge is performed in the machining fluid or the predetermined gas atmosphere.

41. The discharge surface treatment method according to any one of claims 38 to 39, wherein a pulse current with a discharge pulse width not more than 70 microseconds and a peak current value not more than 30 amperes is supplied

between the electrode and the work piece.

42. The discharge surface treatment method according to any one of claims 38 to 41, wherein the powder is powder
5 of metal, a metal compound, or ceramics.

43. (Currently Amended) A discharge surface treatment apparatus that has an electrode consisting of a green compact obtained by compression-molding powder
10 containing metal or a metallic compound and a work piece on which a film is formed, the electrode and the work piece being arranged in a machining fluid or in an air, generates a pulse-like electric discharge between the electrode and the work piece using a power supply apparatus electrically
15 connected to the electrode and the work piece, and forms, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein
20 the powder has an average value of particle diameters not more than 3 micrometers, and the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers.

25 44. (Currently Amended) A discharge surface

treatment apparatus that has an electrode consisting of a green compact obtained by compression-molding powder containing metal or a metallic compound and a work piece on which a film is formed, the electrode and the work piece being arranged in a machining fluid or in an air, generates a pulse-like electric discharge between the electrode and the work piece using a power supply apparatus electrically connected to the electrode and the work piece, and forms, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein powder having a particle diameter not more than 3 micrometers is mixed in a proportion not less than 10% in the powder, and the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers.

45. (Currently Amended) A discharge surface treatment apparatus comprising:

- an electrode consisting of a green compact obtained by compression-molding powder of metal or a metal compound;
- a work piece on which a film is formed; and
- a power supply apparatus electrically connected to the electrode and the work piece,

the discharge surface treatment apparatus generating pulse-like electric discharge between the electrode and the work piece with the power supply apparatus and forming, using discharge energy of the discharge, a film consisting
5 of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the electrode is manufactured from an electrode material that is obtained by mixing a small-diameter powder
10 having a distribution of small particles and a large-diameter powder having an average particle diameter twice or more as large as the small-diameter powder, the large-diameter powder being in 5 to 60 volume percent, and the electrode material being capable of forming a thick
15 film with thickness not less than 100 micrometers.

46. (Currently Amended) A discharge surface treatment apparatus comprising:

an electrode consisting of a green compact obtained
20 by compression-molding powder of metal or a metal compound;

a work piece on which a film is formed; and

a power supply apparatus electrically connected to the electrode and the work piece,

the discharge surface treatment apparatus generating
25 pulse-like electric discharge between the electrode and

the work piece with the power supply apparatus and forming, using discharge energy of the discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the electrode is manufactured from an electrode material that is obtained by mixing a small-diameter powder having a distribution of small particles not more than 3 micrometers and a large-diameter powder having an average particle diameter not less than 5 micrometers, the large-diameter powder being in 5 to 60 volume percent, and the electrode material being capable of forming a thick film with thickness not less than 100 micrometers.

47. The discharge surface treatment apparatus according to claims 45 or 46, wherein the small-diameter powder is powder refined by grinding.

48. The discharge surface treatment apparatus according to any one of claims 45 to 47, wherein the large-diameter powder has a substantially spherical shape.

49. The discharge surface treatment apparatus according to any one of claims 45 to 48, wherein the small-diameter particle and the large-diameter particle have an identical

component.

50. The discharge surface treatment apparatus according to any one of claims 45 to 49, wherein the powder is any
5 one of Co alloy, Ni alloy, and Fe alloy.

51. The discharge surface treatment apparatus according to any one of claims 45 to 40, wherein the large-diameter powder is in 5 to 60 volume percent.

10

52. The discharge surface treatment apparatus according to any one of claims 45 to 50, wherein the large-diameter powder is in 5 to 20 volume percent.

15 53. The discharge surface treatment apparatus according to any one of claims 45 to 52, wherein

the electrode and the work piece are arranged in a machining fluid or a predetermined gas atmosphere, and

electric discharge is performed in the machining
20 fluid or the predetermined gas atmosphere.

54. The discharge surface treatment apparatus according to any one of claims 45 to 53, wherein a pulse current with a discharge pulse width not more than 70 microseconds and
25 a peak current value not more than 30 amperes is supplied

between the electrode and the work piece.

55. (Currently Amended) A discharge surface treatment apparatus comprising:

5 an electrode is made of an electrode material that is capable of forming a thick film with thickness not less than 100 micrometers consisting of a green compact obtained by compression-molding powder with an average value of particle diameters not more than 1 micrometer;

10 a work piece on which a film is formed; and
 a power supply apparatus electrically connected to the electrode and the work piece,

 the discharge surface treatment apparatus generating pulse-like electric discharge between the electrode and
15 the work piece with the power supply apparatus and forming, using discharge energy of the discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece.

20

56. (Currently Amended) A discharge surface treatment apparatus comprising:

 an electrode is made of an electrode material that is capable of forming a thick film with thickness not less
25 than 100 micrometers consisting of a green compact obtained

by compression-molding powder containing a predetermined quality or more of powder with an average value of particle diameters not more than 1 micrometer;

a work piece on which a film is formed; and

5 a power supply apparatus electrically connected to the electrode and the work piece,

the discharge surface treatment apparatus generating pulse-like electric discharge between the electrode and the work piece with the power supply apparatus and forming,
10 using discharge energy of the discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece.

15 57. The discharge surface treatment apparatus according to any one of claims 55 to 56, wherein

the electrode and the work piece are arranged in a machining fluid or a predetermined gas atmosphere, and

electric discharge is performed in the machining
20 fluid or the predetermined gas atmosphere.

58. The discharge surface treatment apparatus according to any one of claims 55 to 56, wherein a pulse current with a discharge pulse width not more than 70 microseconds and
25 a peak current value not more than 30 amperes is supplied

between the electrode and the work piece.

59. The discharge surface treatment method according to
any one of claims 55 to 56, wherein the powder is powder
5 of metal, a metal compound, or ceramics.



手 続 補 正 書

(法第11条の規定による補正)

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5. 補正の対象

明細書及び請求の範囲

6. 補正の内容

(1) 明細書第4頁第16行目乃至第7頁第5行目「上記目的を達成するために、この発明にかかる放電表面処理用電極は、……形成することを特徴とする。」を、

「上記目的を達成するために、この発明にかかる放電表面処理用電極は、金属または金属化合物を含む粉末を圧縮成形した圧粉体を電極として、加工液中または気中において前記電極と被加工物の間に放電を発生させ、その放電エネルギーによって、前記被加工物の表面に電極材料または電極材料が放電エネルギーにより反応した物質からなる被膜を形成する放電表面処理に用いられる放電表面処理用電極において、前記粉末は、 $3\mu\text{m}$ 以下の粒径の平均値を有し、前記電極は、厚さ $100\mu\text{m}$ 以上の被膜形成が可能な前記電極材料であることを特徴とする。

また、次の発明にかかる放電表面処理用電極は、金属、金属化合物またはセラミックスの粉末を圧縮成形した圧粉体を電極として、加工液中または気中において前記電極と被加工物の間に放電を発生させ、その放電エネルギーによって、前記被加工物の表面に電極材料または電極材料が放電エネルギーにより反応した物質からなる被膜を形成する放電表面処理に用いられる放電表面処理用電極において、前記粉末は、鱗片状の形状を有することを特徴とする。

さらに、次の発明にかかる放電表面処理用電極は、金属または金属化合物の粉末を圧縮成形した圧粉体を電極として、加工液中または気中において前記電極と被加工物の間に放電を発生させ、その放電エネルギーによって、前記被加工物の表面に電極材料または電極材料が放電エネルギーにより反応した物質からなる被膜を形成する放電表面処理に用いられる放電表面処理用電極において、前記電極は、厚さ $100\mu\text{m}$ 以上の被膜形成が可能な前記電極材料であって、前記粉末は、小さい粒径の分布を有する小径粉末と、該小径粉末の2倍以上の平均粒径を有する大径粉末とを混合し、前記大径粉末が、 $5\sim 6$